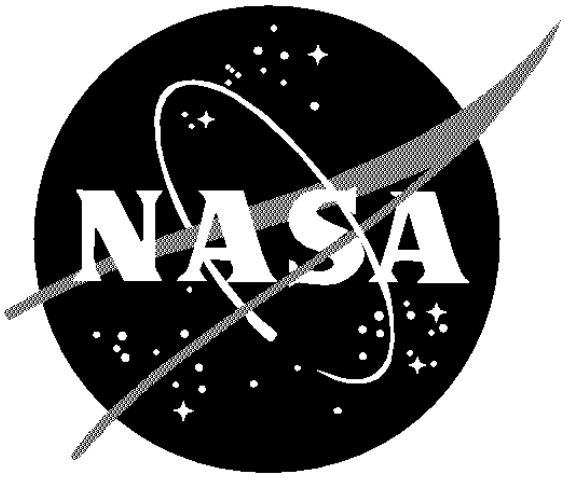

National Aeronautics and Space Administration

June 11, 1997

NRA-97-MTPE-08

RESEARCH ANNOUNCEMENT

BOREAL ECOSYSTEM-ATMOSPHERE STUDY (BOREAS)
GUEST INVESTIGATOR PROGRAM

AND

OPPORTUNITIES TO PARTICIPATE IN THE
TERRESTRIAL ECOLOGY PROGRAM (TEP)

BOREAS Step 1 Proposals Due - July 16, 1997

Last Date to Submit Terrestrial Ecology Program Proposals - September 30, 1997

OMB Approval No. 2700-0087

BOREAL ECOSYSTEM-ATMOSPHERE STUDY (BOREAS) GUEST INVESTIGATOR PROGRAM

AND

OPPORTUNITIES TO PARTICIPATE IN THE TERRESTRIAL ECOLOGY PROGRAM (TEP)

NASA Research Announcement
Soliciting Research Proposals
for
Period Ending
BOREAS: July 16, 1997
TEP: September 30, 1997

NRA-97-MTPE-08
Issued June 11, 1997

Office of Mission to Planet Earth
National Aeronautics and Space Administration
Washington, DC 20546

BOREAL ECOSYSTEM-ATMOSPHERE STUDY (BOREAS)
GUEST INVESTIGATOR PROGRAM
AND
OPPORTUNITIES TO PARTICIPATE IN THE
TERRESTRIAL ECOLOGY PROGRAM (TEP)

I. PURPOSE OF THIS NASA RESEARCH ANNOUNCEMENT

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals for research to utilize the data collected under the joint U.S.-Canada Boreal Ecosystem-Atmosphere Study (BOREAS) as part of a BOREAS Guest Investigator Program. Proposals for research that exploits the BOREAS data set are solicited to address the following general scientific issues: 1) the sensitivity of the boreal forest biome to global change, 2) the carbon cycle, biogeochemistry, and ecological functioning of the boreal forest biome, and 3) ecosystem feedbacks to global change. Proposals are solicited to address the key BOREAS objectives of 1) improving process models that describe the exchanges of radiative energy, water, heat, carbon, and trace constituents between the boreal forest biome and the atmosphere and 2) developing methods for applying the process models over large spatial scales using remote sensing and other integrative techniques. Research activities of interest include intercomparison of data sets, evaluation of BOREAS data products, remote sensing algorithm development and/or improvement, development of new remote sensing data products, and extension of results to regions of boreal forest beyond the BOREAS study region. Proposals should emphasize integration and synthesis of results using existing data sets. Preference will given to proposals that focus on whole system synthesis, that employ innovative analytical approaches combining data sets from multiple sources and/or linking across spatial and temporal scales, and that have the greatest potential for further advancing our understanding of boreal forest biome - atmosphere interactions.

This NASA Research Announcement (NRA) also solicits proposals for research to be conducted as part of the Mission to Planet Earth (MTPE) core science program in Terrestrial Ecology. Proposals to address the following topics are solicited: 1) basic research on thermal remote sensing directed toward assessment of the best ways to utilize thermal data from future satellite sensors for derivation of land surface temperature, 2) assessment of various remote sensing approaches for estimating biomass and/or other canopy structural attributes in medium-high biomass ecosystems and for identifying/quantifying secondary forest regrowth, 3) data fusion (of microwave and optical, time series, or multi-scale data) approaches for improved vegetation classification. *Proposals to address other topics relevant to the goal of the Terrestrial Ecology Program are welcome, but funds have not been specifically set aside for research proposals on other topics; such proposals would be considered as funds become available through normal program turnover.*

II. RELEVANCE TO NASA'S MTPE RESEARCH PROGRAM

NASA's MTPE focuses on studying how the global environment is changing. Using the unique perspective available from space, NASA observes, monitors, and assesses large-

scale environmental processes. MTPE satellite data, complemented by aircraft and ground data, enable us to better understand environmental changes, to determine how human activities have contributed to these changes, and to understand the consequences of such changes. MTPE data and information, which NASA distributes to researchers worldwide, are essential to humans for making informed decisions about sustainable land use and environmental protection (NASA, 1996a).

III. GUIDANCE FOR PROPOSERS

A. Eligibility

Participation in the BOREAS Guest Investigator Program and the Terrestrial Ecology Program is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA research centers, and other government agencies. Civil servants in U.S. government research laboratories are eligible to apply, but may not request civil service salary reimbursement. Participation by non-U.S. Principal Investigators in the BOREAS Guest Investigator Program especially is encouraged within the specific guidelines described in Appendix D, which include a no-exchange-of-funds provision. Both programs are open to current BOREAS and Terrestrial Ecology Program investigators as well to investigators not previously involved in these programs. Any current BOREAS Science Team members interested in seeking NASA funding to continue analyzing BOREAS data are expected to propose in response to the BOREAS Guest Investigator Program portion of this solicitation.

B. Technical Information and Instructions for Proposers

Appendix A provides technical and program information concerning the nature of proposals being sought and amendatory guidance to the general guidelines for responding to NASA Research Announcements contained in Appendix C for the BOREAS Guest Investigator Program. *Please note that the proposal process for the BOREAS Guest Investigator Program will involve two stages: Step 1 requiring brief, summary proposals and Step 2 requiring full proposals.* Appendix B provides the same information for the proposals being sought under the Terrestrial Ecology Program. *Please note that the proposal process for the Terrestrial Ecology Program opportunities involves only full proposals.* Appendix C contains general instructions for responding to NASA Research Announcements. Appendix D contains instructions for foreign participation in this opportunity. Appendix E contains examples of the required institutional declarations and the proposal cover page. Appendix F provides the URL addresses for accessing world wide web home pages with information relevant to this NRA. If electronic access is not available to the prospective proposers, a hard copy of relevant reference(s) can be requested by calling (202) 358-3552 and leaving a voice mail message. Please leave your full name and address, including zip code, and your telephone number, including area code. *Prospective investigators are urged to read the information in all of the Appendices carefully and to follow the specific guidelines therein carefully.*

C. Proposal Submission and Review

Step 1 proposals to the BOREAS Guest Investigator Program may be submitted at any time during the period ending at 4:30 pm, EDT, on July 16, 1997. Step 2 proposals will be due no later than 2 months following notification from NASA of the Step 1 proposal review results and recommendations.

Proposals to the Terrestrial Ecology Program may be submitted at any time during the period ending at 4:30 pm, EDT, on September 30, 1997.

Step 1 proposals for the BOREAS Guest Investigator program may be up to 5 pages of text, single-spaced, with type no smaller than 12-pt., including abstract and references. Full proposals for both programs (i.e., Step 2 proposals for BOREAS) may be up to fifteen pages of text, single-spaced, with type no smaller than 12-pt., including abstract and references. Detailed information on proposal format and content is provided in Appendices A and B for the BOREAS Guest Investigator Program and the Terrestrial Ecology Program, respectively.

Proposals will be subjected to external peer review utilizing either mail evaluation, panel evaluation, or both. A NASA management review for technical and logistical feasibility and cost analysis (if funds are requested) also will be conducted. The evaluation criteria to be used are listed in Appendices A and B for the BOREAS Guest Investigator Program and the Terrestrial Ecology Program, respectively. Step 1 proposals submitted for the BOREAS Guest Investigator program will reviewed by a panel. Following the panel review, NASA will place each Step 1 proposal in one of four groups: 1) high priority, 2) medium priority, 3) low priority, and 4) non-responsive/unimplementable.

Proposers will be notified as soon as possible of the categorization of their Step 1 proposal, and will receive copies of any comments from the panel. Proposers will receive specific recommendations concerning the submission of a Step 2 proposal based on the categorization their proposal received (see Appendix A, section III-A). Step 2 proposals submitted for the BOREAS Guest Investigator program will reviewed as a group (using both mail and panel review) and in the same time-frame. NASA's selection decisions will be made and announced all at once. Full proposals submitted in response to the opportunities identified for the Terrestrial Ecology Program will be reviewed as they come in, and decisions will be made and announced as the review for each individual proposal or group of proposals is completed.

Proposals for the BOREAS Guest Investigator Program should request no more than 2 years of funding to start no sooner than January 1, 1998. Proposals for the Terrestrial Ecology Program should request no more than 3 years of funding to start no sooner than August 15, 1997. Annual review of progress reports will be required for renewal during 1998-2000. Publication of results in the peer-reviewed literature is expected.

A complete proposal schedule for the BOREAS Guest Investigator program is given below:

Step 1 Proposals Due:	4:30 pm, EDT, July 16, 1997
Step 2 Proposals Due:	2 months after notification of categorization of Step 1 proposal

Announcement of Final Selections:	December, 1997

A complete proposal schedule for the Terrestrial Ecology Program is given below:

Last Date to Submit a Terrestrial Ecology Program Proposal:	4:30 pm EDT, September 30, 1997
Announcement of Final Selections:	As reviews are completed and decisions made, but no later than December 31, 1997

The following items apply only to this announcement.

Identifier:	NRA-97-MTPE-08
Submit Proposals to:	BOREAS / TEP Code Y 400 Virginia Avenue, SW, Suite 700 Washington, DC 20024 USA

For overnight mail delivery purposes only the recipient telephone number is (202) 544-2775.

Number of Copies Required:	10
Submit One Additional Copy: of **Foreign Proposals** to:	NASA Headquarters Office of External Relations Mission to Planet Earth Division Mail Code IY 300 E Street, SW Washington, DC 20546
Selecting Official for BOREAS Guest Investigator Program:	Director, Science Division Office of Mission to Planet Earth
Selecting Official for Terrestrial Ecology Program:	Manager, Terrestrial Ecology Program Science Division Office of Mission to Planet Earth
Obtain Additional Information from:	Dr. Diane E. Wickland Manager, Terrestrial Ecology Program Code YS NASA Headquarters 300 E Street, SW Washington, DC 20546 Telephone: (202) 358-0245 FAX: (202) 358-2771 Diane.Wickland@hq.nasa.gov

Your interest and cooperation in participating in this opportunity are appreciated.

William F. Townsend
Acting Associate Administrator for
Mission to Planet Earth

Enclosures:

APPENDIX A

TECHNICAL INFORMATION ON BOREAS GUEST INVESTIGATOR PROGRAM, AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THE BOREAS GUEST INVESTIGATOR PORTION OF THIS NRA, AND INSTRUCTIONS FOR PROPOSERS

I. BACKGROUND

A. Goals and Objectives

BOREAS is a multi-disciplinary, large-scale field and remote sensing study that has been implemented jointly by the United States and Canada. The original goal of BOREAS was to improve our understanding of the interactions between the boreal forest biome and the atmosphere in order to clarify their roles in global change. BOREAS focused on improving our understanding of the exchanges of radiative energy, sensible heat, water, CO_2, and trace gases between the boreal forest and the lower atmosphere. A primary objective was to collect the data needed to improve models of the important processes controlling these exchanges near the northern and southern limits of the biome in order to develop understanding of the potential effects of global change on it, in particular, the effects of altered temperature and precipitation patterns. Another was to develop methods for applying process models over large spatial scales using remote sensing and other integrative approaches (Sellers et al., 1995).

The scientific issues of importance for BOREAS were: 1) the sensitivity of the boreal forest biome to changes in the physical climate system, 2) the carbon cycle and biogeochemistry in the boreal forest, and 3) biophysical feedbacks on the physical climate system. These scientific issues provided the motivation for the design and execution of a cooperative U.S.-Canada field study involving elements of climatology, hydrology, biogeochemistry, and ecology, with remote sensing playing a strong integrating role.

B. Study Sites

The large-scale study area for BOREAS, called the BOREAS Study Region, is a 1000 x 1000 km area covering most of Saskatchewan and Manitoba in central Canada. Within that region are two specific study areas -- the Northern Study Area (NSA) near Thompson, Manitoba, and the Southern Study Area (SSA) near Prince Albert, Saskatchewan. Within each of these two study areas were modeling sub-areas (defined by the BOREAS Science Team), flux tower sites, and auxiliary and process study sites. The transect running from southwest to northeast between the two study areas was a focus for some observations as well.

C. Study Design

BOREAS field observations began in 1993 with a baseline monitoring program and a pilot intensive field campaign. The baseline monitoring continued uninterrupted through 1996.

There were five field campaigns of two to three week duration held in 1994, spaced to sample winter, spring thaw, spring, summer, and fall and lasting for a combined total of 123 days. Additional observations were obtained in 1996. Four field campaigns of three to four week duration were conducted to sample critical processes during winter, spring thaw, summer, and late fall. During the field campaigns, researchers worked on the ground to simultaneously take a wide range of meteorological, ecological, hydrological, biogeochemical, and remote sensing-related measurements. Research aircraft were flown over the two study areas and the transect between them to make a wide variety of remote sensing and flux measurements. Most available satellite data also were obtained for the field campaigns as well as for intervening periods and dates prior to 1993.

The field observation phase of BOREAS has been completed, and BOREAS is now in a data analysis phase which is expected to continue for several years. It should be noted that a few agencies within the Canadian and U.S. governments have recently decided to fund a limited program of continued observations at a subset of the BOREAS flux tower sites. This new program has been named Boreal Ecosystem Research and Monitoring Sites (BERMS). Close cooperation between BERMS and BOREAS is anticipated. NASA is a participant in the BERMS program, but BERMS-related field observations and analysis are outside the scope of this NRA and will not be considered.

D. Data System

The BOREAS Project has created the BOREAS Information System (BORIS) to receive data from individual BOREAS investigators, put it into a uniform format, and distribute it to officially recognized BOREAS Science Team members. Every BOREAS Science Team member has early access to every other investigator's preliminary data. NASA's MTPE data policy does not allow for any period of exclusive use by an investigator or a Science Team; however, in practice, data set preparation, quality checking, and documentation for data sets so complex and varied as are those of BOREAS takes time. As of this writing only a very few data sets have been properly readied for release to the general public. When a BOREAS data set is ready for release it is transferred to the NASA EOSDIS (Earth Observing System Data and Information System) DAAC (Distributed Active Archive Center) for Biogeochemical Dynamics at the Oak Ridge National Laboratory (ORNL). The URL for the ORNL DAAC is listed in Appendix F. Investigators selected under this NRA will become official BOREAS Science Team members and enjoy early access to BOREAS preliminary data and data products.

More detailed information concerning BOREAS research, data, and project activities to date can be found on the BOREAS Home Page (see Appendix F for URL) or by consulting recent summary publications (Sellers et. al., 1995; Hall, et al., 1996; see also the BOREAS Bibliography on the BOREAS Home Page)

II. TYPES OF PROPOSALS REQUESTED

NASA's MTPE research and analysis program is interested in receiving proposals for research that will take full advantage of the data sets already collected under BOREAS. Investigators selected under this announcement will become BOREAS Science Team members. Proposals for research that exploits the BOREAS data set are solicited to

address the following general scientific issues: 1) the sensitivity of the boreal forest biome to global change, 2) the carbon cycle, biogeochemistry, and ecological functioning of the boreal forest biome, and 3) ecosystem feedbacks to global change. Proposals are solicited to address the key BOREAS objectives of 1) improving process models that describe the exchanges of radiative energy, water, heat, carbon, and trace constituents between the boreal forest biome and the atmosphere and 2) developing methods for applying the process models over large spatial scales using remote sensing and other integrative techniques. Other research activities of interest include intercomparison of data sets (e.g., across sites, across study areas, between years, of multiple approaches to the same data product or result), evaluation of BOREAS data products, remote sensing algorithm development and/or improvement, development of new remote sensing data products, and extension of results to regions of boreal forest beyond the BOREAS study region. Proposals should emphasize integration and synthesis of results using existing data sets. Preference will given to proposals that focus on whole system synthesis, that employ innovative analytical approaches combining data sets from multiple sources and/or linking across spatial and temporal scales, and that have the greatest potential for advancing our understanding of boreal forest biome - atmosphere interactions.

Proposals to make new observations in the BOREAS study region will be considered not responsive to the BOREAS Guest Investigator program. Proposals to make new observations could be proposed in response to the opportunities available in the Terrestrial Ecology Program described in Appendix B of this announcement under the conditions described therein for "other topics relevant to the Terrestrial Ecology Program."

The BOREAS Guest Investigator Program is an opportunity for analysis and integration of existing data and for synthesis of results only. While the use of existing BOREAS data is a requirement for the BOREAS Guest Investigator Program, the research to be conducted need not be confined to the use of BOREAS data or to the BOREAS sites only. Effective use of external (i.e., non-BOREAS) data is welcome, and proposers should consider offering such external data to BOREAS, when appropriate, for inclusion in BORIS and/or long-term archival at the ORNL DAAC.

A. Resources Available from NASA

NASA's MTPE Science Division will make available at least $1,500,000 per year for two years for the BOREAS Guest Investigator program. Current plans are to select and fund approximately 20 investigations with annual budgets in the range of $30,000 - $150,000.

B. Scientific Issues of Interest

1. Sensitivity of the Boreal Forest Biome to Global Change. Research to utilize the BOREAS data set and, if relevant, exercise model improvements developed under BOREAS in order to explore possible global change scenarios is desired. Such studies should employ realistic and mechanistic approaches, capitalizing on the process understanding derived to date from BOREAS. These studies need not be limited to consideration of climate change only; other types of global change are of interest also.

2. Carbon Cycle, Biogeochemistry, and Ecological Functioning of the Boreal Forest Biome. The multi-scale nature of BOREAS provides data for the investigation of carbon

cycling and related issues of biogeochemical and ecological function that are vitally important to understanding and quantifying the role of boreal ecosystems in the global carbon cycle. Data on carbon dynamics (i.e., processes, fluxes, and balance) were acquired during BOREAS at scales ranging from the plot level (0.1 to 1.0 m^2) to the site level (~1 km^2) and to regional scales (10 - 1000 km^2). The BOREAS data set presents an excellent opportunity to evaluate the carbon balance at the site level, and it may be possible to make some estimates of annual carbon flux at the regional scale as well. Proposals to conduct such studies are expected to provide estimates of uncertainty. There is a need for additional analysis to better understand the respiration data collected during BOREAS's field phase. Disturbance, particularly fire, is likely to have a significant impact on regional carbon balance. Study of the impact of disturbance on carbon balance or of the relationship between carbon balance and landscape age is also of interest.

3. Ecosystem Feedbacks to Global Change. Proposals are desired offering research to utilize the BOREAS data set to identify, quantify, and/or predict the effects of changes in boreal forest ecosystem function on other parts of the Earth system, including but not limited to the physical climate system. Investigations that realistically focus on the short-term (days to seasons) coupling between the ecosystem and the atmosphere as well as those that focus on longer term (years to centuries) feedbacks that might involve time lags, thresholds, or consideration of episodic events are encouraged. Seasonal and longer time scales could be addressed in the context of feedback mechanisms between forest characteristics and the timing and magnitude of hydrologic processes.

The current BOREAS Science Team is working on many of these scientific issues now and can be expected to continue to do so in the future. New BOREAS Science Team members selected under this NRA should expect to interact with, and very likely collaborate with, other BOREAS Science Team members in addressing some of these large scientific issues.

The scientific issues described in items 1-3 above provide examples of the types of work that would be relevant to the BOREAS Guest Investigator Program, but the examples provided are by no means comprehensive. They do represent some of the best ideas of the scientific leadership within the current BOREAS Science Team and of NASA BOREAS management. Other research topics may be proposed, but it will be incumbent on the proposer to articulate the relevance and priority of the research to NASA and the objectives of the BOREAS Guest Investigator program.

C. Research Activities of Interest

1. Improving Models. Research to elucidate the process-level controls on the exchanges of radiative energy, water, heat, carbon, and trace constituents between the boreal forest biome and the atmosphere is desired. This was one of BOREAS's original objectives and remains a high priority. The improvement of ecological, biogeochemical, hydrological, and climatic models and the development of predictive capabilities depend upon our ability to understand and effectively capture the key controls on critical ecological processes. This understanding can be used to make models more realistic and mechanistic, but can also be used as a basis for improving parameterizations that may not capture the processes themselves. Proposals that exploit BOREAS's abundant biophysical data to better parameterize short- and medium-range weather models as well as longer-term climate models are of particular interest. Investigations that make effective use of BOREAS's

comprehensive collection of remotely sensed data are strongly encouraged. Proposals that seek to couple differing types of models (e.g., radiative transfer models, ecological, and hydrological process models) to enable integrated ecosystem analysis are of interest. Proposals to improve parameters required by modelers through innovative remote sensing data analysis and modeling are encouraged.

Particular areas where BOREAS data can improve the performance of operational weather forecast and climate models are in improved parameterization of surface energy balance, particularly evapotranspiration. Incorporation into the models of the effects of airborne smoke and other aerosols could greatly improve computations of surface incident long- and short-wave radiation. There is also a critical need to incorporate into models new estimates of boundary layer entrainment rates obtained from BOREAS data.

Processes of interest with respect to surface energy balance and hydrology for BOREAS include those within frozen versus unfrozen soils, the controls on evapotranspiration, temperature responses at different times of year, radiation processes in the cold season, and the interactions among annual precipitation, water balance, and temperature with respect to canopy carbon and water fluxes.

Process of interest with respect to the carbon cycle and biogeochemistry of the boreal forest biome include respiration, moss layer functionality with respect to carbon exchange, periodic disturbances (e.g., fire) and regeneration, and the processes controlling trace gas emissions as environmental controls vary across space and time on the boreal landscape.

2. Scaling. Research to extend process-level understanding derived at small, local scales to the two entire BOREAS study areas and to the broader boreal region is desired. This is likely to involve application of process models over large spatial scales using remote sensing and other integrative techniques, but other methods of extrapolation or integration may be applicable. Development of methods for applying process models over large spatial scales using remote sensing and other integrative techniques was another of BOREAS's original objectives, and it remains a priority. Examination of scaling issues is critical for linking plot, stand and regional scale understanding and measurements gained in BOREAS. For example, larger scale interactions need to be examined by extending flux measurements over the entire biome and through time using remotely sensed data bases and tower fluxes as inputs, and using the aircraft large-area transects as validation.

Up-scaling in hydrology could focus on use of simulation modeling and remote sensing to work from the local (tower) scale to the scale of the NSA and SSA catchments (White Gull and Sapochi Rivers, respectively) and from the catchment to the large watershed (Saskatchewan and Nelson Rivers, respectively) scales and to continental extents. The interaction of point and small area water balances with the larger scale, and with catchment/watershed hydrologic response, are of interest.

Up-scaling in ecology and biogeochemistry could focus on the rich database of carbon exchange -- especially of carbon dioxide and methane. Chamber-based flux measurements lend themselves to process studies of within site, i.e., fine spatial scale, controls on gas exchange. Extrapolating these measurements to larger scales has always been a challenge but, because of the experimental design, the BOREAS data set is an ideal tool to explore these issues. A common feature for trace gas fluxes is their high degree of variability.

BOREAS data will enable research to incorporate the observations of the landscape, plant community, and physical climate controls into process-level models and then extrapolate them using remotely sensed distributions of the controlling parameters.

Research that exploits the BOREAS data set to test and/or extend understanding derived through BOREAS to larger regions of the boreal forest biome is of interest. Such studies might involve comparison of the BOREAS sites with other well-studied boreal forest biome research sites.

Research to address up-scaling challenges due to deficiencies in the BOREAS data set (e.g, minimal data on forest regeneration following fire, insufficient data on the role of lakes, etc.) would be particularly welcome.

3. Evaluation of Key BOREAS Remote Sensing Data Products. BOREAS investigators have produced a number of data products derived from remotely sensed data that may be of great use to the broader scientific community as well as to the individual investigations for which they were created. Some of these could benefit from further evaluation. In some cases the same type of data product was created using differing data sources (e.g., land cover from radar vs. optical data); evaluation of the utility of one versus the other for differing scientific applications would be of interest. Data available for such studies include biophysical parameter maps of land cover class, biomass density, FAPAR, LAI, freeze-thaw dynamics, surface temperature, albedo, down-welling PAR, and long-wave radiation. Approaches could involve the input of the various parameter products into process models and comparing predicted to observed fluxes at the plot, stand, and regional scale. Evaluation of the applicability of various remote sensing data products for scaling-up is particularly encouraged.

Some lower priority or difficult to process field and aircraft instrument data sets from BOREAS have only recently been made available to the BOREAS Science Team. Proposals to utilize these data sets or to develop advanced parameter estimation algorithms using them will be considered. Examples of these data sets include multi-angular (BRDF) observations of the tower flux sites from the PARABOLA instrument, high-spectral resolution data over tower flux sites and auxiliary sites from the SE-590 instrument, and laser profiler data on canopy and terrain height from the SLICER instrument.

4. Comparison of Data Sets. Comparative studies can be used to derive additional understanding of system function or to evaluate the validity of differing approaches to achieve the same result or data product. BOREAS data provide excellent opportunities for both types of comparisons.

Inter-site comparisons and analyses are of interest. Such studies could address one or more of these important boreal ecosystem gradients: 1) the climate gradient (by analyzing data from the northern and southern study areas for one or more of the tower site pairs -- NSA fen/SSA fen, NSA old black spruce/SSA old black spruce, NSA old jack pine/SSA old jack pine, and NSA young jack pine/SSA young jack pine), 2) stand age gradient (old jack pine versus young jack pine in each study area), 3) “functional type” gradient (deciduous versus coniferous versus peatland), 4) moisture gradient (wet to dry: fen to old black spruce to old jack pine). Comparisons between 1994 and 1996 data sets and results are also of interest.

Studies are desired that compare and evaluate alternative methods for determining boreal forest biome - atmosphere exchanges (e.g., for carbon, measure/model fluxes and infer changes in pool sizes versus measure/model pool sizes and their changes and infer fluxes from these). Such methods include those for total ecosystem fluxes (e.g. tower fluxes, aircraft fluxes, tethered balloon), those for component flux measurements (soil chambers, branch bags, stem chambers, sub-canopy eddy-correlation) and those that assess carbon stocks (e.g., measurement of allometry, net primary production, litter-fall, and soil carbon).

Comparative studies should be focused on developing new understanding of system function or developing confidence in methods -- not just on comparisons for their own sake.

5. Algorithm Development and Improvement. Studies that combine existing BOREAS data sets to develop and/or improve algorithms that exploit existing sensor systems to map terrestrial biophysical parameters are encouraged -- especially as they address problems pertinent to boreal ecosystem-atmosphere interactions. Studies that develop such algorithms in ways that they could be easily adapted to exploit future sensor systems would be particularly welcome. Given the wide array of remote sensing data types available from BOREAS, the use of multiple data types is encouraged.

6. Development of New Remote Sensing Data Products. Research to develop and validate new data products based on BOREAS data, particularly remote sensing data, is invited. Such new data products should be geared toward driving models or enabling scaling activities relevant to the BOREAS Guest Investigator Program. Validation work should not attempt new field observations, but rather, when feasible, exploit existing, independent data sets from BOREAS or other sources.

The research activities described in items 1-6 above provide examples of the types of work that would be relevant to the BOREAS Guest Investigator Program, in approximate order of priority, but the examples provided are by no means comprehensive. They do represent the best ideas of the scientific leadership within the current BOREAS Science Team and of NASA BOREAS management. Other research activities may be proposed, but it will be incumbent on the proposer to articulate the relevance and priority of the research to NASA and the BOREAS Guest Investigator program.

C. Science Team Participation

All investigators selected as a result of this announcement will be come new members of the BOREAS Science Team, joining the members of the current team, and will be expected to participate fully in BOREAS Science Team activities. A new Science Steering Committee (SSC), composed of representatives of the expanded BOREAS Science Team who remain active conducting BOREAS research, will be established at the end of 1997. Proposers interested in providing scientific leadership in the Guest Investigator phase of BOREAS may wish to so indicate this desire in their proposal and describe the nature of the desired leadership role within the SSC or other Science Team activities. Investigators who wish to coordinate or organize a synthesis activity or intercomparison of data, algorithms, or models involving more than one investigation are invited to propose to do so. Proposers offering such scientific coordination or organization activities should take

care to provide adequate information in the management plan to demonstrate the activity can be successfully conducted and to budget for any additional required resources (e.g., travel funds for working meetings) in the cost plan.

D. Data Plans

Investigators selected in response to this NRA will be expected to adhere to the BOREAS data policy. They will be made members of the BOREAS Science Team and allowed access to preliminary data not yet ready for public release. New investigators will be expected to participate in data quality evaluation, as appropriate, and share any data from external sources they may bring to their BOREAS study. All BOREAS Science Team investigators are expected to fully acknowledge and respect the contributions of the original data gatherers and providers; it is anticipated that this will often require offering co-authorship or other appropriate acknowledgment on publications (e.g., when the data have not been previously published).

III. AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THE BOREAS GUEST INVESTIGATOR PORTION OF THIS NRA AND INSTRUCTIONS FOR PROPOSERS

A. Step 1 Proposals: Content, Format, and Evaluation Process

The proposal process for the BOREAS Guest Investigator Program will involve two stages: Step 1, requiring brief, summary proposals, and Step 2, requiring full proposals. All investigators interested in being considered for funding through the BOREAS Guest Investigator program must submit a Step 1 proposal.

Step 1 proposals may be up to 5 pages of text, single-spaced, with type no smaller than 12-pt., including abstract and references. The text should describe concisely the research to be conducted, emphasizing the research objectives, technical approach, and expected results. No more than 2 figures or tables may be appended in excess of this page limit. Also not included in this page total is the cover page. The Step 1 proposal cover page should contain the following: a short, descriptive title for the proposed effort; the name of the proposing organization(s); names, addresses, telephone numbers, FAX number, electronic mail addresses, and affiliations of the Principal Investigator and all Co-Investigators; and a total cost estimate by year. The Step 1 proposal should bear official institutional signatures. Any additional material submitted with the Step 1 proposal will be discarded.

Step 1 proposals submitted for the BOREAS Guest Investigator program will reviewed by a peer review panel on the basis of their intrinsic merit, relevance to NASA's objectives, and cost. The criteria listed below will be used in evaluating individual Step 1 proposals. These criteria supersede those listed in section (i) of Appendix C, and are in order of decreasing importance.

1. The relevance and responsiveness of the proposed research to the goals and objectives of NASA’s Mission to Planet Earth research program and to

the goals and objectives of the BOREAS Guest Investigator program, as described in the announcement.

2. The intrinsic scientific and technical merits of the investigation.

3. The cost of the investigation, primarily, the relationship of the proposed cost to available funds.

Following the panel review, NASA will place each Step 1 proposal in one of four groups:

1) high priority (well-conceived proposals of high scientific and technical merit and strongly relevant to the goals of BOREAS)
2) medium priority (relevant proposals of sound scientific and technical merit, but of lower priority than those categorized as high priority)
3) low priority (proposals of lesser relevance to BOREAS, and/or containing major scientific or technical deficiencies, and/or with high costs relative to their projected scientific returns)
4) non-responsive/unimplementable (proposals not relevant to the goals of BOREAS, or proposals so scientifically or technically flawed that they appear to be unimplementable, or proposals with cost estimates exceeding the resource levels available for this NRA)

Proposers will be notified as soon as possible of the categorization of their Step 1 proposal, and will receive copies of any comments from the panel. Proposers whose Step 1 proposals were categorized as high priority will receive a specific recommendation encouraging submission of a Step 2 proposal. Proposers whose Step 1 proposals were categorized as medium priority will receive a recommendation that Step 2 proposals from them will be acceptable, but not specifically encouraged. Proposers whose Step 1 proposals were categorized as low priority will receive a recommendation that Step 2 proposals from them will be considered, but are discouraged. Proposers whose Step 1 proposals were categorized as non-responsive/unimplementable will receive a specific recommendation strongly discouraging submission of a Step 2 proposal. Step 2 proposals will be due 2 months after the date of notification of the results of the Step 1 proposal review.

B. Step 2 Proposals: Full Proposal Content and Format

The content of the Step 2 proposal should provide sufficient detail to enable a reviewer to assess the value of the proposed research, its relation to BOREAS objectives, and the probability that the investigators will be able to accomplish the stated objectives within the requested resources and schedule. The technical part of the proposal should be limited to the equivalent of 15 pages of text, single-spaced, with type no smaller than 12 pt., including abstract and references. The cover page, table of contents, management plan, data plan, cost plan, and short resumes need not count in this total. Additional pertinent information may be added as appendices.

Each proposal should contain the following materials assembled in the order given.

1. Cover Letter. Each proposal should be prefaced by a cover letter signed by an official of the investigator's institution who is authorized to legally bind the organization to the proposal and its content (unless the signature appears on the proposal itself). The cover letter should refer to the BOREAS Guest Investigator Program.

2. Proposal Cover Page. The proposal cover page should contain the following: a short, descriptive title for the proposed effort; the name of the proposing organization(s); names, addresses, telephone numbers, FAX numbers, electronic mail addresses, and affiliations of the Principal Investigator and all Co-Investigators; and a year by year budget summary, including a total for all years. An example cover page is provided in Appendix E.

3. Table of Contents (recommended length: 1 page). A table of contents listing the page numbers for key sections of the proposal, including the data, management, and cost plans, should be provided.

4. Abstract and Technical Plan (not to exceed 15 pages). The abstract should summarize the research proposed in one page or less. It should contain a simple, concise overview of the investigation, its objectives, its scientific approach, expected results, and the value of its results to BOREAS. It is very important that this abstract be specific and accurately represent the research to be conducted.

The main body of the proposal should contain a full statement of the research to be undertaken and should describe objectives, scientific relevance, technical approach, and expected significance of the work. The key elements of the project should be clearly identified and related to each other. The methods or approaches to be used should be described, and, as appropriate, the advantages of the selected methods or approaches over alternatives should be discussed. The anticipated results should be identified and their relation to the proposal's stated objectives and the objectives of BOREAS should be discussed. It is recommended, unless the investigators are proposing something very new or unusual, that any background, introductory, or general scientific justification sections be limited to a total of 1-2 pages so that the bulk of the proposal can be devoted to the actual work to be done for BOREAS. The research should be described in sufficient detail that peer reviewers can adequately assess the scientific methods and quality of the work proposed.

If the proposer has been a BOREAS investigator, a brief summary of research results and accomplishments in this past BOREAS research should be included in the technical plan.

A list of references used in the Technical Plan should be provided.

5. Data Plan (recommended length: 1/2 - 1 page). All proposals should provide a brief Data Plan describing the investigator's commitment to and plans for sharing data and for interacting with the BOREAS data management systems (both BORIS and the ORNL DAAC, as appropriate). This plan should describe the type and amount of data to be requested from BORIS and/or other investigators and the desired time of delivery. The plan should also describe how any data products to be created or additional, ancillary data sets to be obtained will be provided to BORIS to be shared with other BOREAS Science Team members and, ultimately, the external community. *Resources (i.e., personnel and equipment) for supporting the Data Plan should be identified in the Cost Plan.*

6. Management Plan (recommended length: 1/2 - 2 pages, depending on complexity). The Management Plan should outline the roles and responsibilities of all investigators and collaborators and indicate the relationships among these roles and responsibilities within the group. The management plan should also identify what contractor and/or non-institutional support is anticipated and who will be providing it.

7. Cost Plan for U.S. Proposals Only (recommended length: 1 page per budget year, 1 budget summary page, 1/2 - 2 pages of explanation/justification, 1/2 - 2 pages detailing other funded projects). A detailed cost plan must be provided. Costs should be broken down into all of the following categories that apply: salaries and wages, including staff-months and rates for all personnel; benefits; supplies; services; equipment purchases; data purchases; computer services; publication costs; communications; travel; other; and overhead. Any unusual requests for funds (e.g., computer equipment, expensive equipment purchases) must be specially justified.

Participation in BOREAS Science Team activities must be accounted for in each investigator's Cost Plan. Investigators should budget for at least two meetings in the first year and one the year thereafter.

Contributions from any cost-sharing plan or other support for the proposed research should be detailed.

Current funding from other sources, including the level of funding and the title or brief description of the supported research, should be listed.

8. Resumes. Brief resumes (1-2 pages) for all named investigators should be appended to the proposal.

9. Declarations and Certifications. Certifications bearing official institutional signatures regarding drug-free workplace requirements, debarment and suspension, and lobbying must be appended. Example forms are provided in Appendix E.

10. Other Enclosures. Any other material pertinent to the consideration of the proposal may be attached as an Appendix. This might include preprints or reprints of relevant publications, background on new measurement or analysis approaches, or letters of support and/or participation by scientists and/or agencies in other countries. Inclusion of general materials that will not aid in the evaluation of the proposal is specifically discouraged.

C. Selection Process and Evaluation Criteria for Step 2 Proposals

The review for the Step 2 proposals submitted to the BOREAS Guest Investigator program will consist of letter reviews by at least 3 scientific peers with specialized technical expertise in the research topic(s) being proposed, followed by a panel review. Step 2 proposals also will be reviewed by NASA managers to identify any logistical, implementation, cost, and/or management concerns. Under Step 2, NASA will only consider those proposals that had their scientific objectives and technical approach evaluated in Step 1.

The criteria listed below will be used in evaluating individual proposals. These criteria supersede those listed in section (i) of Appendix C, and are of approximately equal importance.

1. The intrinsic merits of the investigation, including:

   (a) the overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

   (b) the effectiveness of the investigation in building upon past research results, and in providing synthesis and integration of data and results.

   (c) the qualifications, capabilities, and relevant experience of the Principal Investigator and any Co-Investigators or collaborators as an indication of their ability to carry the investigation to a successful conclusion within the requested resources, including timely publication of peer-reviewed journal articles.

   (d) the ability and commitment of the investigator's institution to provide the necessary support to ensure that the investigation can be completed satisfactorily.

2. The relevance and responsiveness of the proposed research to the goals and objectives of NASA's Mission to Planet Earth research program and to the goals and objectives of the BOREAS Guest Investigator program, as described in the announcement, including:

   (a) the feasibility of accomplishing the stated scientific goals of the proposed investigation and advancing understanding of one or more of the scientific issues identified in the announcement.

   (b) the quality and appropriateness of the data plan

3. The cost of the investigation including consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

NASA may desire to accept only a portion of a proposer's investigation, in which case the investigator will be given the opportunity to accept or decline such partial acceptance. In cases in which two or more proposals address similar problems and/or adopt similar approaches to data analysis, NASA may desire joint participation on the part of two or more proposers in a single project. If such overlap involves more than one funding organization, NASA and those organizations will confer and mutually agree to the disposition of those proposals.

IV. REFERENCES

Hall, F. G., P. J. Sellers, and D. L. Williams. 1996. Initial Results from the Boreal Ecosystem-Atmosphere Experiment, BOREAS. *Silva Fennica* 30(2-3):109-121.

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Sellers, P., F. Hall, J. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M. G. Ryan, B. Goodison, P. Crill, K. J. Ranson, D. Lettenmaier, and D. E. Wickland. 1995. The Boreal Ecosystem-Atmosphere Study (BOREAS): An Overview and Early Results from the 1994 Field Year. Bull. Am. Met. Soc. 76(9):1549-1577.

APPENDIX B

TECHNICAL INFORMATION ON RESEARCH SOUGHT UNDER THE TERRESTRIAL ECOLOGY PROGRAM, AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THE TERRESTRIAL ECOLOGY PROGRAM PORTION OF THIS NRA, AND INSTRUCTIONS FOR PROPOSERS

I. BACKGROUND

The overall goal of the Terrestrial Ecology Program is:

> *To contribute to an improved understanding of the function of global terrestrial ecosystems, their interactions with the atmosphere, and their role in the cycling of the major biogeochemical elements and of water.*

The overall program strategy is to use remote sensing to observe the distribution and structure of the Earth's terrestrial ecosystems, conduct process studies to elucidate ecosystem function, and develop realistic models that simulate these ecosystem properties and processes. Emphasis is on integrating process understanding with remote sensing observations and ecological modeling to extend understanding across spatial and temporal scales.

In pursuit of its goal the Terrestrial Ecology (TE) Program funds field observations and process studies, aircraft and space-based remote sensing, and modeling of the biological and ecological processes that influence, and are influenced by, global change. The research includes major field campaigns (BOREAS is a current example) and studies that have ranged from measurements of trace gas fluxes and carbon/nitrogen pools to ecosystem functioning at landscape and regional scales. Study of the interaction of electromagnetic radiation with terrestrial ecosystems in order to understand remotely sensed information is also supported strongly. These studies involve theoretical modeling, controlled field and laboratory observations, and the development of new analytical methods.

In recent years, the Terrestrial Ecology Program has focused on five research areas that address Mission to Planet Earth's goals and objectives within the U.S. Global Change Research Program. These are: 1) land surface characterization by remote sensing: methods and procedures, 2) land surface characteristics: distribution and change, 3) carbon balance and carbon dioxide fluxes, 4) trace gas biogeochemistry, and 5) basic remote sensing research (NASA, 1993).

II. RESEARCH SOUGHT UNDER THE TERRESTRIAL ECOLOGY PROGRAM

NASA is interested in proposals for research to be conducted as part of the Mission to Planet Earth (MTPE) core science program in Terrestrial Ecology. Proposals to address the following specific remote sensing and methods (i.e., research areas 1 and 5 in Section I above) topics are solicited: 1) basic research on thermal remote sensing directed toward

assessment of the best ways to utilize thermal data from future satellite sensors for deriving land surface temperature, 2) assessment of various remote sensing approaches for estimating biomass and other canopy structural attributes in medium-high biomass ecosystems and for identifying and quantifying secondary forest regrowth, 3) data fusion (microwave and optical and/or thermal and rigorous scaling across either spatial or temporal scales) approaches for improved vegetation classification or characterization. ***Proposals to address other topics relevant to the goal of the Terrestrial Ecology Program are welcome, but funds have not been specifically set aside for research proposals on other topics; such proposals will be considered as funds become available through normal program turnover.*** It should be noted that opportunities to pursue research in the other research areas identified in Section I have been offered recently. These include NRA-96-MTPE-03 on land cover and land-use change, the NSF/DOE/NASA/USDA/EPA Terrestrial Ecology and Global Change (TECO) program, and NRA-97-MTPE-02 on the effects of tropical forest conversion as part of the Large-Scale Biosphere-Atmosphere Experiment in Amazônia (see Appendix F for URLs).

A. Resources Available

The Terrestrial Ecology Program has an annual budget of roughly $15 million. Most of these funds are committed to on-going research projects funded through previous research announcements or on the basis of unsolicited proposals. Approximately $600,000 has been reserved to fund research on the three specific remote sensing and methods topics identified above. Additional funds may be made available if the quality and relevance of proposals received warrant a greater investment. ***No funding has been reserved for proposals on other topics relevant to the Terrestrial Ecology Program, but it is anticipated that it will be possible to fund a few such proposals as funds become available through normal program turnover. Those proposals in other topic areas meriting consideration for selection and funding based on the peer and program reviews will be held for up to 1 year from the date of submission pending the availability of funds.***

B. Research Topics of Interest

1. Thermal Remote Sensing. NASA is planning to fly several new sensors with thermal channels (e.g., MODIS, ASTER, Landsat-7) in the near future. The selected science teams for these instruments are planning to produce basic land surface temperature data products, but there is a sense that more could be done with the advanced measurement capabilities of the new sensors to improve the land surface temperature data products. A variety of approaches have been suggested, but there is no clear consensus on which to pursue. Therefore, NASA desires to conduct new basic remote sensing research coupled with an assessment process to cross-compare and validate the most promising of these approaches. The goal of these studies will be to determine what could be done in the next 3-5 years to improve or complement the land surface temperature data products to be derived from future thermal sensors.

The MODIS Project sponsored a workshop in September, 1996, (Snyder, et. al., 1997) that evaluated the current status of remote sensing of land surface temperature (LST) and recommended future research directions. Many of these recommendations are highly relevant to the research activities sought through this solicitation. These recommendations

are: 1) make intercomparisons of different LST algorithms in their accuracy and sensitivity with real data in well-characterized surface conditions, and with numerical simulations in wide ranges of atmospheric and surface conditions, 2) study the dependence of LST on solar and view angles, and the impact on LST applications through *in-situ* measurements and modeling, 3) enhance the relationship between land-surface temperature/emissivity and atmospheric profile products, 4) improve our knowledge of the relationships between the radiative and the aerodynamic temperatures so that LST measured from space can be used to validate numerical model outputs, and 5) consider the possibility of conducting a field campaign to advance the research and to implement field LST validation.

In addition, NRA-95-MTPE-03 described the most pressing needs for the MODIS land surface temperature product (see Appendix F for URL). To summarize, expertise was desired in the use of thermal data in canopy or terrain thermal feature modeling to derive improved land surface temperature estimates which account for the directional viewing effects of MODIS and which can be more closely related to actual surface temperatures. This requirement has not yet been addressed through EOS, and the NASA Terrestrial Ecology Program desires to take some initial steps toward remedying the situation. Investigators proposing to conduct research in this area should expect to work closely with other investigators to be selected under this topic and with the existing instrument science teams, as appropriate, to evaluate the various approaches.

2. Estimation of Biomass/Canopy Structural Attributes and Identification of Secondary Regrowth. Progress in understanding global carbon budgets is impeded by a lack of accurate and extensive biomass data for the Earth's forest ecosystems and by great uncertainties concerning the total area and status of disturbed forests and secondary regrowth. This problem is particularly acute for tropical forest ecosystems. Remote sensing approaches have often been touted as being able to deliver quantitative measurements of biomass. However, single sensor approaches rigorously evaluated to date usually "saturate" (i.e., lose their sensitivity to increasing amounts) at moderate to high levels for biomass for global ecosystems (e.g., for current radar technology at about 200 Mg/ha). Similarly, remote sensing approaches (usually single sensor) to identify and characterize disturbed forests and secondary regrowth have had only limited success in providing the type of information needed by ecologists.

NASA's Terrestrial Ecology Program is interested in exploring new and innovative approaches and technologies to improve and/or quantify our ability to remotely sense biomass, other important, related canopy structural attributes, and/or the area and status of disturbed forests and secondary regrowth for large regions. Also of interest are new and innovative techniques for estimating stand history and disturbance history using remotely sensed data. One promising avenue of research might lie in data fusion (i.e., combining radar, optical and thermal data; actively and passively sensed data; time series of data), but all innovative approaches will be considered. If improved approaches can be demonstrated through this research, the Terrestrial Ecology Program will be very interested to consider incorporating them at a future date into the proposed Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) and/or future assessments of global carbon balance.

Research to be conducted under this topic must be innovative, offer new approaches and new interpretations, show promise to advance our capabilities to estimate biomass or other important canopy structural attributes, identify and quantify disturbed forests and

secondary regrowth, or estimate stand/disturbance history, and be applicable to a broad geographic scope. At this time, NASA is not interested in incremental improvements of existing methods, approaches to work in low biomass ecosystems, site-specific or scene-dependent approaches, or routine data analysis under this research topic. Such proposals will be deemed not responsive and will not be considered.

3. Data Fusion for Vegetation Classification. The Office of Mission to Planet Earth's new focus on land cover and land use change, along with the Terrestrial Ecology Program's continued interest in land surface characterization, have generated a renewed interest in land cover classification (NASA, 1996c; see Appendix F for URL to access via the World-Wide Web). Ecological models and ecosystem assessment require land cover classifications that correctly discriminate among a number of vegetation classes. It seems plausible that remotely sensed data from different spectral domains, which are sensitive to differing vegetation properties (e.g., optical being sensitive to chemical composition, microwave being sensitive to water and structure), could provide more useful information for classification than could remotely sensed data from only one spectral domain. Similarly, time series of data, capturing and utilizing phenological variability, could provide unique information for vegetation classification. However, such approaches have been rarely attempted and the few early demonstrations have been scene-specific. *Innovative research to advance satellite remote sensing capabilities to identify and/or correctly classify vegetation types using multiple satellite sensor data sources is desired. Such research proposals should address classification accuracy and the characterization of uncertainties.*

C. Need for A Problem-Oriented Approach and Periodic Assessment

A remote sensing science workshop held in winter, 1995, (Wickland and Smith, 1995) made a number of recommendations that are relevant to the research solicited in this NRA. In particular, it was recommended that NASA consider creating opportunities to better align the objectives of the remote sensing research with the ecological research within the Terrestrial Ecology Program by focusing the remote sensing research to be pursued on a few very specific and centrally important ecological questions that could be addressed using remotely sensed data. The workshop further recommended that these questions be pursued by collaborative teams of scientists as opposed to individual investigations. The research topics solicited under this NRA seem well-suited for such a team approach. In addition, the workshop recommended that more attention be paid to periodically establishing benchmarks and assessing progress within the program.

Therefore, proposers should plan to become a member of a small team (2-5 investigations) focused on one of the topics described in Section II-B above and with the goal of providing a state-of-the-art assessment of what can be done using remote sensing to address the underlying ecological problem at the end of the investigation. Proposers should budget accordingly for the shared work and for the interactions that will be required in this team approach: nominally one full team meeting per year and, perhaps, 1-2 trips per year for working groups or joint field activities.

III. FUTURE DIRECTIONS

The Terrestrial Ecology Program portion of this NRA represents a first step toward a practice of issuing regular announcements (nominally annually) of research topics of interest to the NASA Terrestrial Ecology Program. Planning is currently underway to explore potential new research topics for the program as well as to facilitate the evolution of existing research topics toward greater compatibility with NASA MTPE's new research priorities for the late 1990's (NASA, 1996c). Planning activities will be conducted in 1997 to explore potential new directions in multi-directional remote sensing, trace gas biogeochemistry, interannual variability within the biosphere, and to add a remote sensing/spectral measurement capability to selected large-scale field manipulations (e.g., Free-Air CO_2 Enrichment (FACE) studies). Scientists interested in contributing to these planning activities should contact the primary point of contact for this NRA.

IV. AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THE TERRESTRIAL ECOLOGY PORTION OF THIS NRA AND INSTRUCTIONS FOR PROPOSERS

A. Proposal Content and Format

The proposal process for the Terrestrial Ecology Program will not involve Step 1-type proposals. Only full proposals are sought.

The guidelines for content and format of full proposals described in Section III-B of Appendix A should be followed in the Terrestrial Ecology Program proposals with the following exceptions: 1) no data plan need be submitted, 2) all relevancy criteria should focus on the activities solicited for the Terrestrial Ecology Program (not, the BOREAS Guest Investigator program), and 3) travel costs for meetings to be included in the cost plan should follow the guidance provided in Section II-C of this Appendix B.

B. Selection Process and Evaluation Criteria

The goals of the proposal evaluation process will be to identify the best scientific approaches to meeting the goals and objectives of the Terrestrial Ecology Program. The criteria listed below will be used in evaluating individual proposals. These criteria supersede those listed in section (i) of Appendix C, and are of approximately equal importance.

1. The intrinsic merits of the investigation, including:

    (a) the overall scientific or technical merit of the proposal

    (b) the unique and innovative methods, approaches, or concepts demonstrated by the proposal.

    (c) the qualifications, capabilities, and relevant experience of the Principal Investigator and any Co-Investigators or collaborators as an indication of their ability to carry the investigation to a successful conclusion within the requested

resources, including timely publication of peer-reviewed journal articles.

(d) the ability and commitment of the investigator's institution to provide the necessary support to ensure that the investigation can be completed satisfactorily.

2. The relevance and responsiveness of the proposed research to the goals and objectives of NASA's Mission to Planet Earth research program in Terrestrial Ecology, as described in the announcement.

3. The cost of the investigation including consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

The review for the Terrestrial Ecology Program proposals will consist of letter reviews by international scientists with specialized technical expertise which may or may not be followed by a scientific peer review panel (depending on the timing and number of proposals received). All proposals also will be reviewed by NASA managers to identify any logistical, implementation, cost, and/or management concerns. These proposals will be reviewed as they come in, and decisions will be made and announced as the review for each individual proposal or group of proposals is completed.

NASA may desire to accept only a portion of a proposer's investigation, in which case the investigator will be given the opportunity to accept or decline such partial acceptance. In cases in which two or more proposals address similar problems and/or adopt similar approaches to data analysis, NASA may desire joint participation on the part of two or more proposers in a single project. If such overlap involves more than one funding organization, NASA and those organizations will confer and mutually agree to the disposition of those proposals.

V. REFERENCES

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APPENDIX C

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS (JANUARY 1997)

(a) General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR. Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) Transmittal Letter or Prefatory Material.

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) **Restriction on Use and Disclosure of Proposal Information**. Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the

understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description**.

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach**. For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) **Personnel**. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) **Facilities and Equipment.**

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling

that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) **Proposed Costs.**

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(9) **Security**. Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support**. For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d) **Renewal Proposals**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of

the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals**.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals**. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques**. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k) **Selection for Award**.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) **Cancellation of NRA**. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

APPENDIX D

GUIDELINES FOR FOREIGN PARTICIPATION

NASA accepts proposals from entities located outside the U.S. in response to this NRA. Proposals from non-U.S. entities should not include a cost plan. Non-U.S. proposals, and U.S. Proposals that include non-U.S. participation, must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. Such endorsement should indicate the following points: (1) The proposal merits careful consideration by NASA; and (2) If the proposal is selected, sufficient funds will be made available by the sponsoring foreign agency to undertake the activity as proposed.

Proposals, along with the requested number of copies and Letter of Endorsement must be forwarded to NASA in time to arrive before the deadline established for this NRA. In addition, one copy of each of these documents should be sent to:

NASA Headquarters
Office of External Relations
Mission to Planet Earth Division
Mail Code IY
Washington, DC 20546
USA

Any materials sent by courier or express mail (e.g., Federal Express) should be sent to:

NASA Headquarters
Office of External Relations
Mission to Planet Earth Division
Mail Code IY
300 E Street, SW
Washington, DC 20024-3210

All proposals must be typewritten in English. All non-U.S. proposals will undergo the same evaluation and selection process as those originating in the U.S. Non-U.S. proposals and U.S. Proposals that include non-U.S. participation, must follow all other guidelines and requirements described in this NRA. Sponsoring non-U.S. agencies may, in exceptional situations, forward a proposal without endorsement to the above address, if review and endorsement are not possible before the announced closing date. In such cases, however, NASA's Mission To Planet Earth Division of the Office of External Relations should be advised when a decision on the endorsement is to be expected.

Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating the NRA. Copies of these letters will be sent to the sponsoring government agency.

APPENDIX E

EXAMPLES OF REQUIRED DECLARATIONS AND PROPOSAL COVER PAGE

Certification Regarding
Debarment, Suspension, and Other Responsibility Matters
Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211). Copies of the regulation may be obtained by contracting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, DC. 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statues or commission of embezzlement theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

_____

Organization Name PR/Award Number or Project Name

_____

Name and Title of Authorized Representative

_____

Signature Date

ED Form GCS-008 (REV.12/88)

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about -

(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs, and
(4) The penalties that may be imposed upon employees for drug abuse violations in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will -

(1) Abide by the terms of the statement; and
(2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than
five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2) , with respect to any employee who is so convicted -

(1) Taking appropriate personnel action against such an employee, up to and including termination; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved
for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

_____

Organization Name PR/Award Number or Project Name

_____

Name and Title of Authorized Representative

_____

Signature Date

ED 80-0004

CERTIFICATION REGARDING LOBBYING

Certification for Contracts, Grants, Loans, and Cooperative Agreements.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000, and not more than $100,000 for each such failure.

_____

Signature and Date

_____

Name and Title of Authorized Representative

_____

Organization Name

BOREAS / TEP: NRA-97-MTPE-08

Title: _____

Principal Investigator Name:_____

Department:_____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators:

Name	Institution	Telephone	Electronic Mail
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Budget:

1st Yr.: _____ 2nd Yr.: _____ 3rd Yr. (only for TEP): _____
Total: _____

Requested Start Date: _____ Requested Duration: _____

Category Proposing Under: _____

(Category choices: A. BOREAS: 1) the sensitivity of the boreal forest biome to global change, 2) the carbon cycle, biogeochemistry, and ecological functioning of the boreal forest biome, or 3) ecosystem feedbacks to global change / B. TEP: 1) thermal, 2) biomass/structure/secondary forest, 3) data fusion for classification, 4) other)

Authorizing Official: _____ _____
(Name) (Institution)

APPENDIX F

ELECTRONIC ADDRESSES

The URL references listed below are available for on-line access via the following World Wide Web Home-Pages:

(1) NASA MTPE Home Page:

http://www.hq.nasa.gov/office/mtpe/

MTPE Science Plan:
http://www.hq.nasa.gov/office/mtpe/draftsciplan/mtpe-srp.htm

Land Cover & Land Use Change NRA:
http://www.hq.nasa.gov/office/mtpe/nra9603a.html

NRA on Effects of Tropical Deforestation as part of LBA:
http://www.hq.nasa.gov/office/mtpe/nra97mtpe02/nra9702.html

EOS/MODIS NRA: http://www.hq.nasa.gov/office/mtpe/nra9503a.html

(2) BOREAS Home Page:

http://boreas.gsfc.nasa.gov/

(3) ORNL DAAC Home Page:

http://www-eosdis.ornl.gov/

(4) TECO Program Announcement"

http://www.er.doe.gov/production/grants/lab97_02.html

(5) EOS Project Home Page:

http://eospso.gsfc.nasa.gov/

Land Surface Temperature Workshop Report:
http://eospso.gsfc.nasa.gov/eos_observ/1_2_97/Jan_Feb97.html